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**Abrams et al.**

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(54) **SIGNAL MONITORING SYSTEM INCLUDING EMI-SHIELDING COUPLER**

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(51) **Int. Cl.**

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***A61B 5/00*** (2006.01)
***A61B 5/1455*** (2006.01)
*H01R 13/6598* (2011.01)

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CPC ........... ***A61B 5/0075*** (2013.01); ***A61B 5/14552*** (2013.01); ***A61B 5/743*** (2013.01); *A61B 2562/182* (2013.01); *A61B 2562/228* (2013.01); *H01R 13/6598* (2013.01)

(58) **Field of Classification Search**

CPC ..... H01R 13/658; H01R 9/032; H01R 12/775
USPC ........................................ 439/607.47–607.49
See application file for complete search history.

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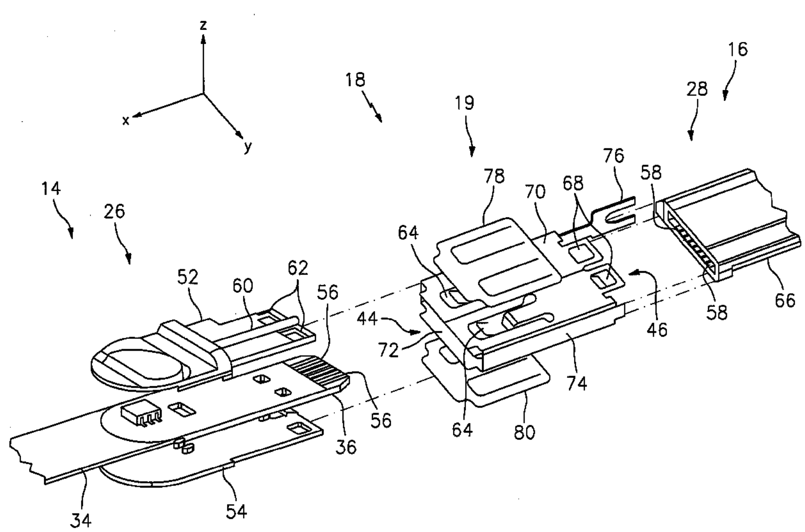
(57) **ABSTRACT**

An apparatus for electrically and mechanically coupling a connection portion of a sensor assembly with a connection portion of an interface cable is provided. The apparatus includes a frame having an EMI shielding material. The frame defines a first port operable to engage the connection portion of the sensor assembly and a second port operable to engage the connection portion of the interface cable. The frame includes attachment features operable to mechanically secure the connection portion of the sensor assembly and the connection portion of the interface cable relative to the frame. The frame is configured to provide a Faraday Cage around substantially all of the connection portion of the sensor assembly and the connection portion of the interface cable when the connection portions are in coupled configuration.

**20 Claims, 7 Drawing Sheets**



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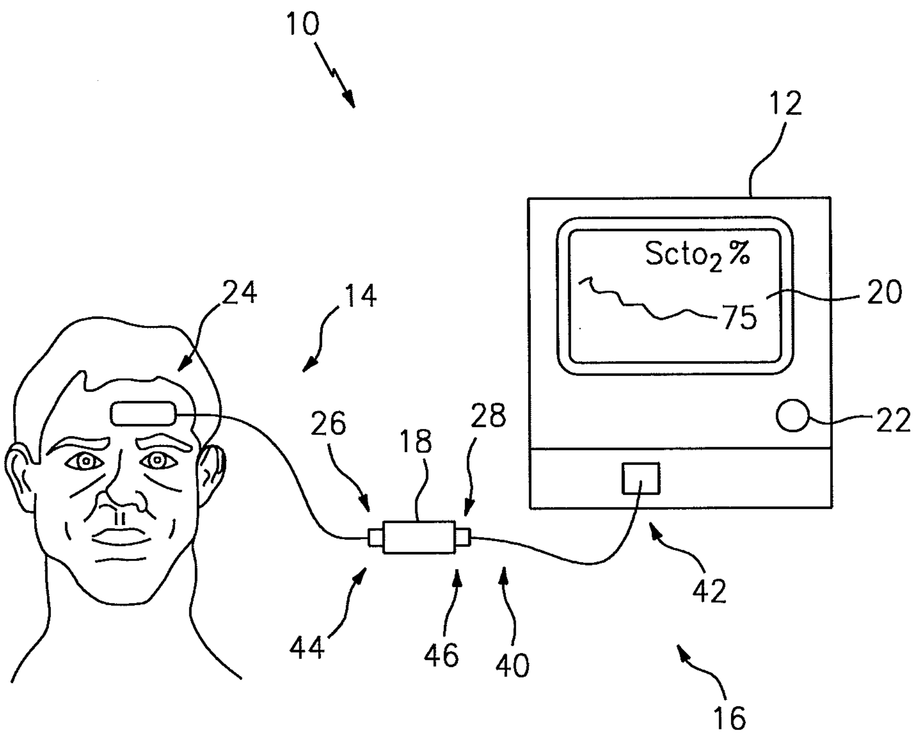


FIG. 1

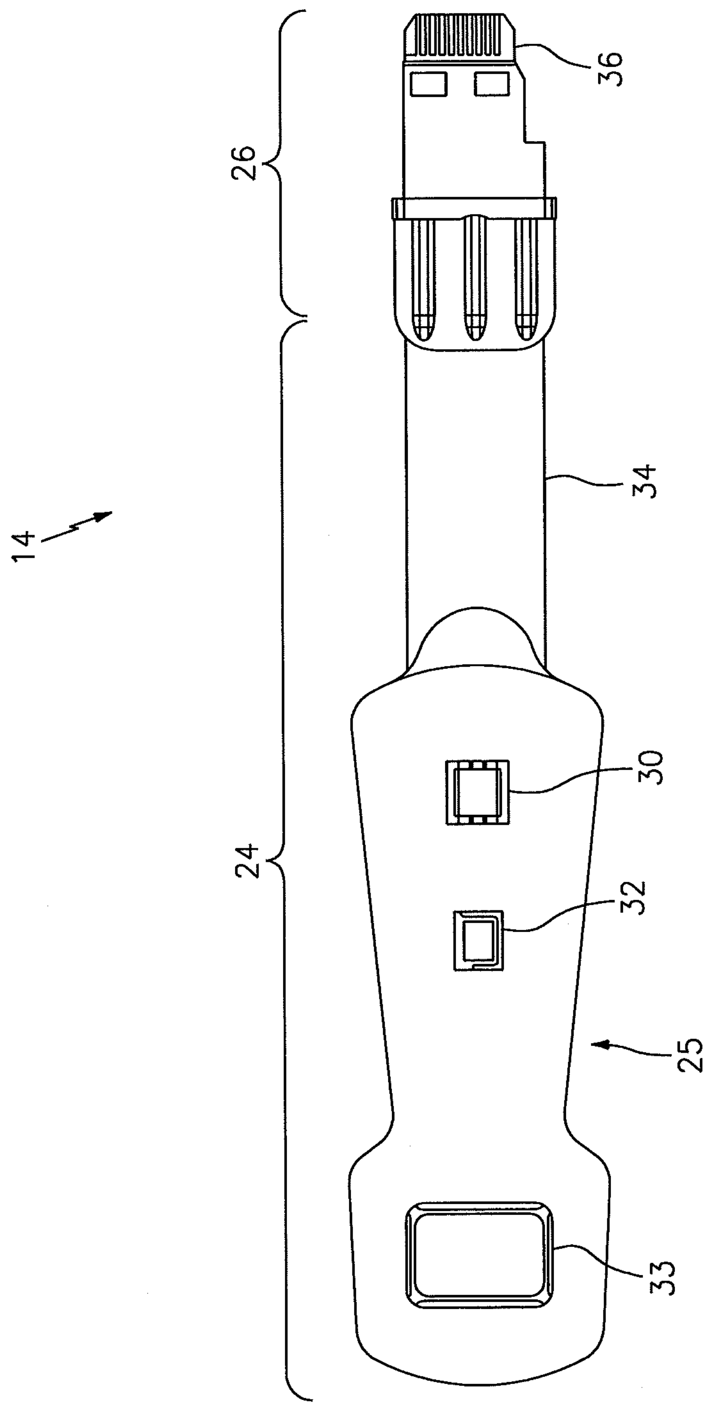


*FIG. 2*

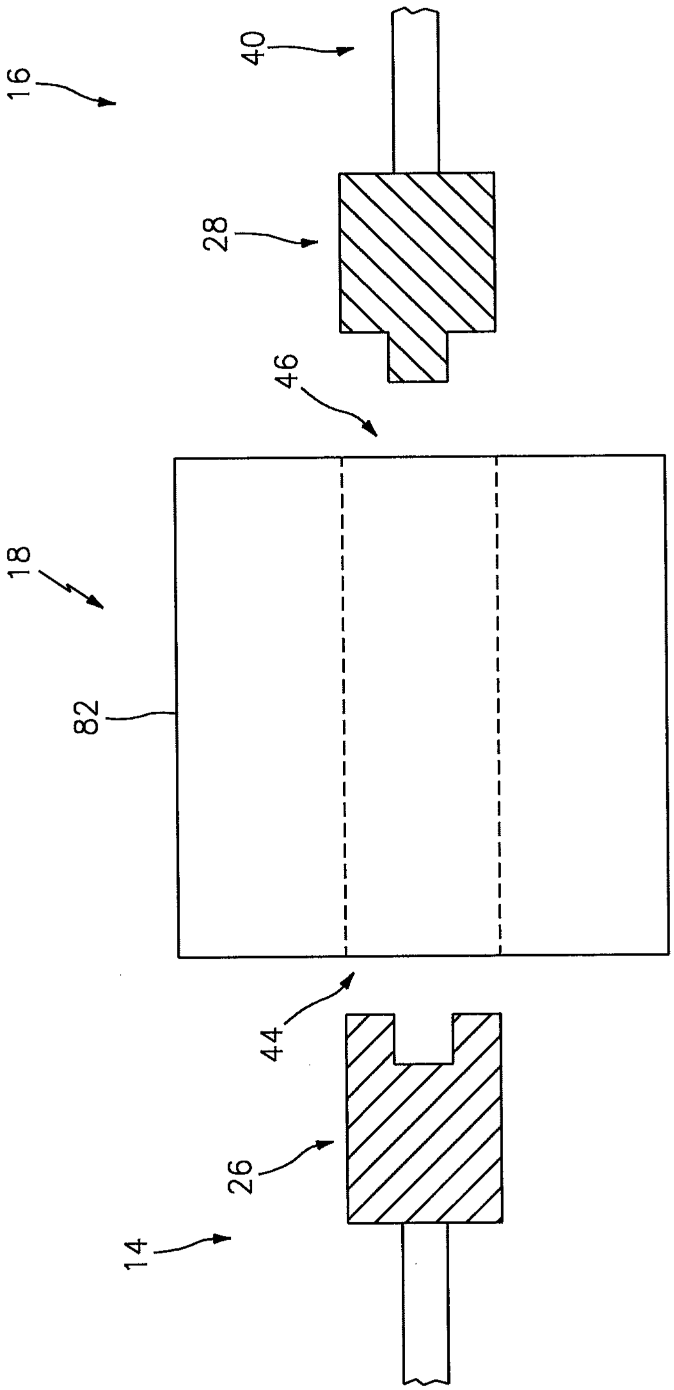


FIG. 3

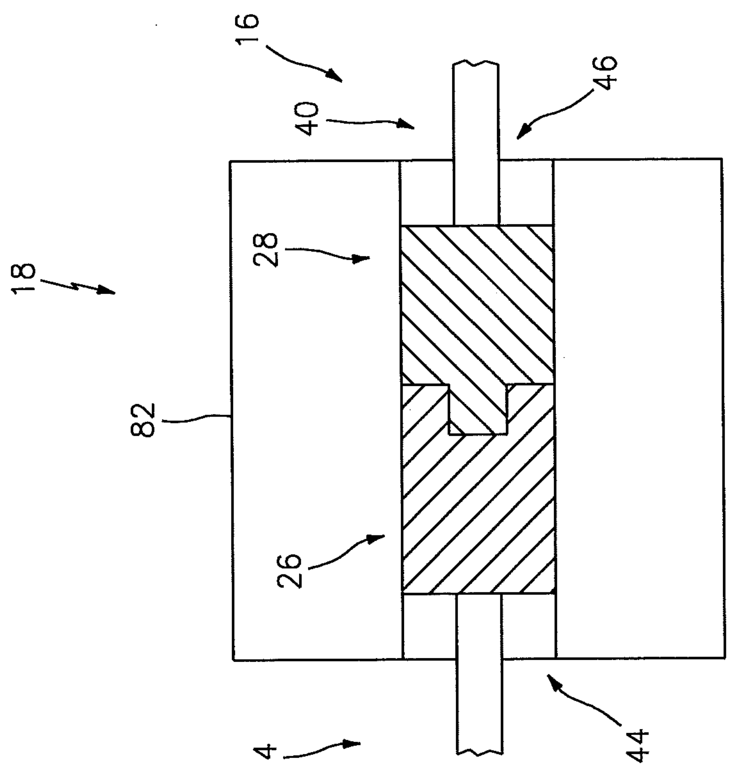


FIG. 4

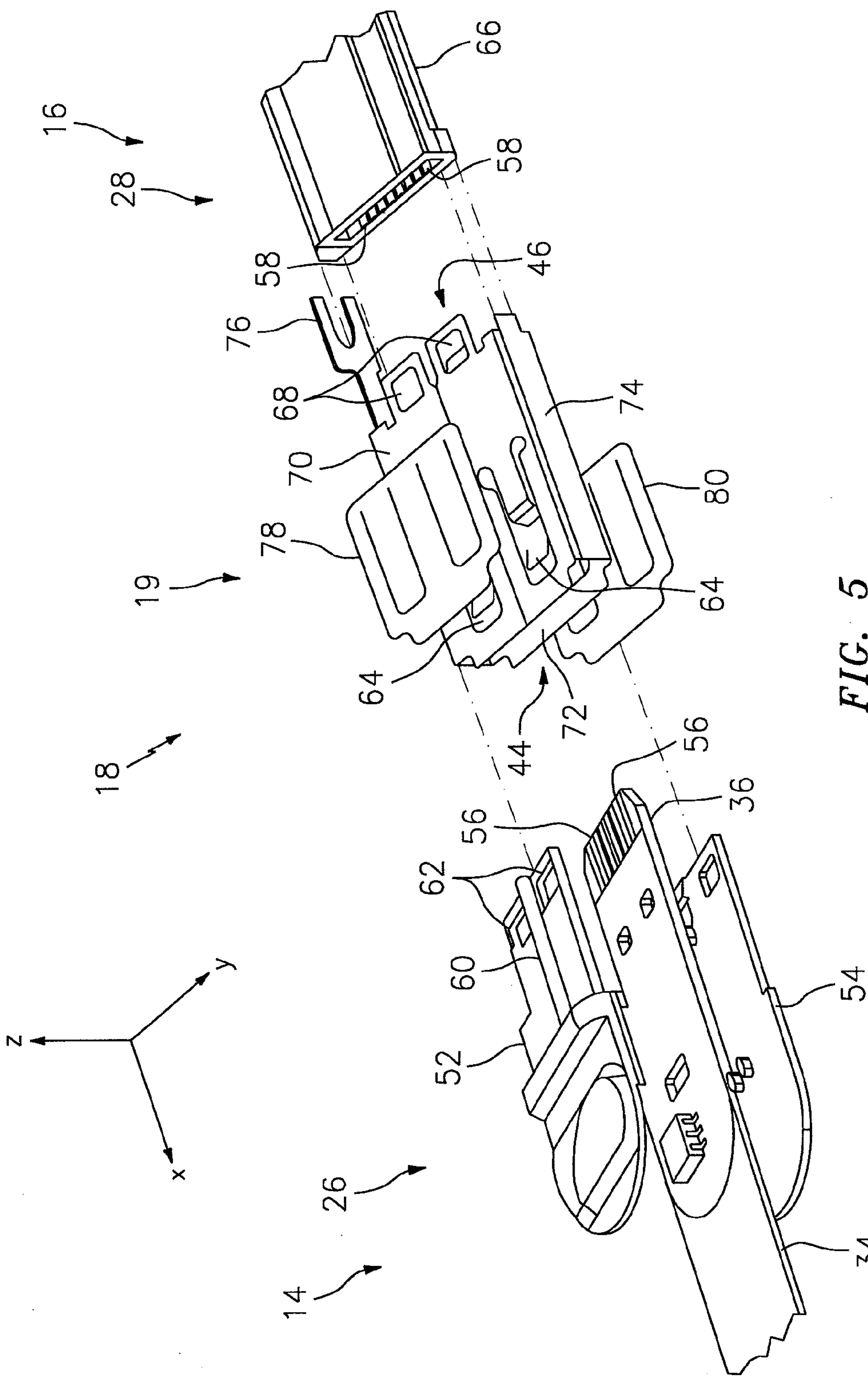
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*FIG. 5*

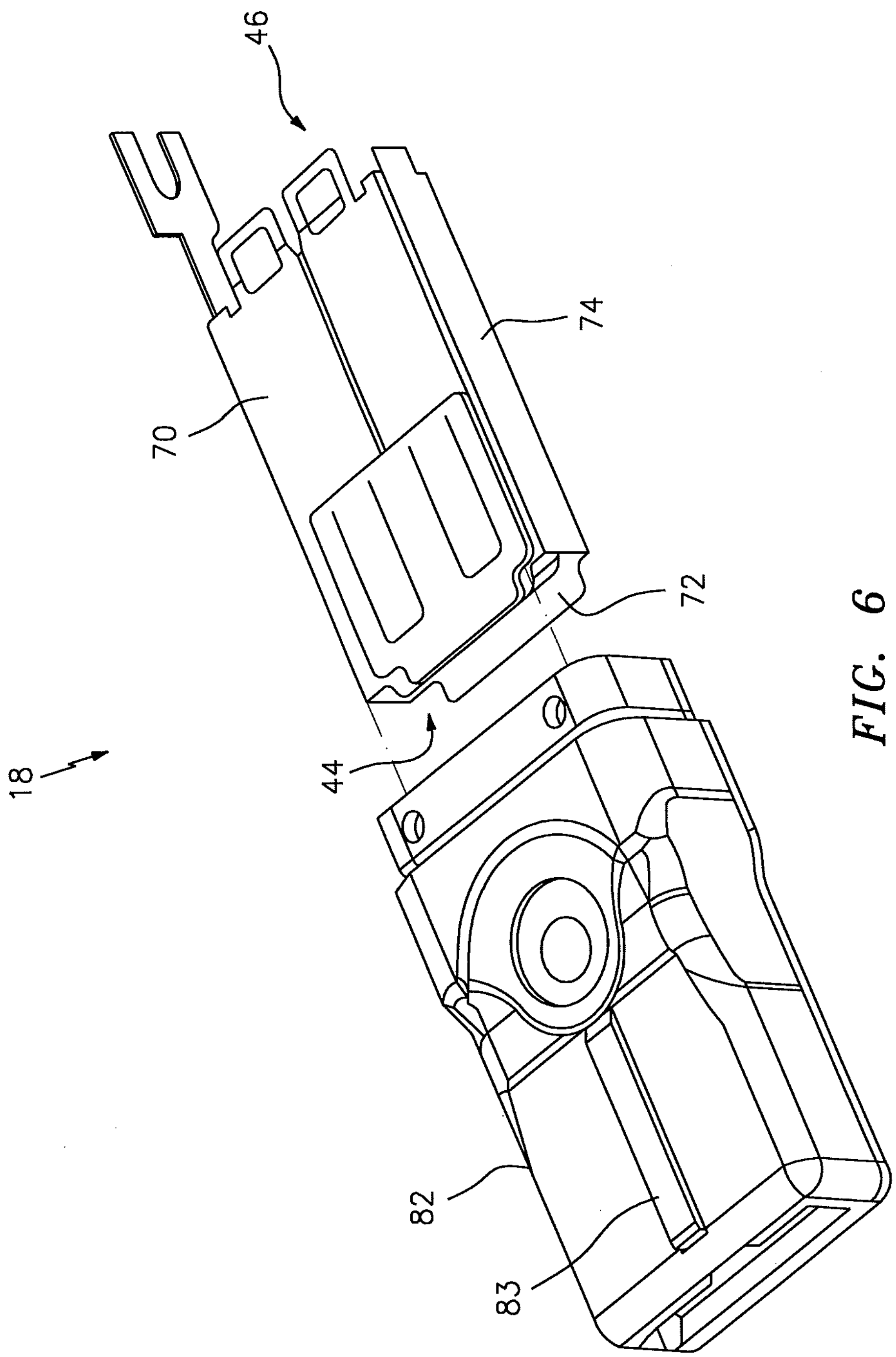


FIG. 6

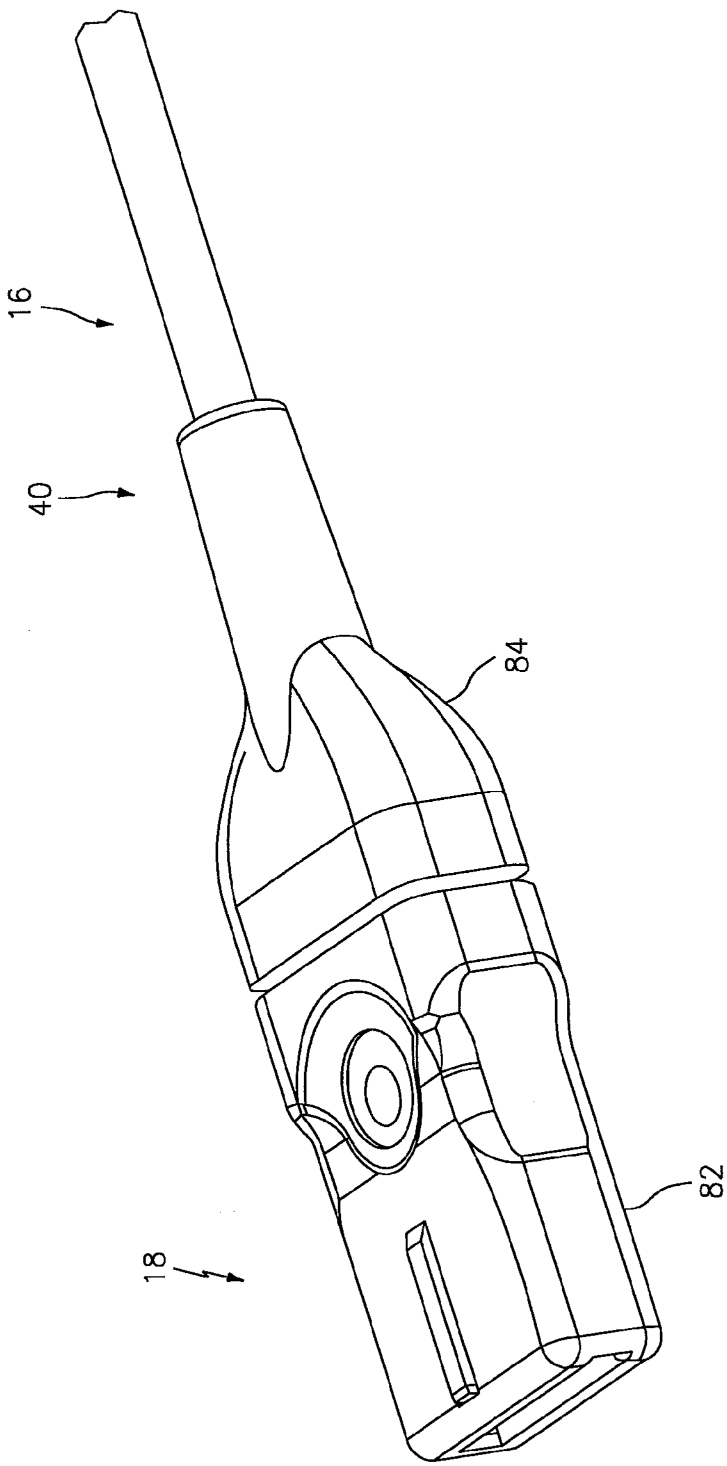


FIG. 7

# SIGNAL MONITORING SYSTEM INCLUDING EMI-SHIELDING COUPLER

## BACKGROUND OF THE INVENTION

1. Technical Field

This invention relates to signal monitoring systems in general, and in particular to signal monitoring systems that include a coupler that shields against electromagnetic interference (EMI).

2. Background Information

Near-infrared spectroscopy (NIRS) is an optical spectrophotometric method that can be used to continuously monitor tissue oxygenation. NIRS is based on the principle that light in the near-infrared range (700 nm to 1,000 nm) can pass easily through skin, bone and other tissues where it encounters hemoglobin located mainly within micro-circulation passages; e.g., capillaries, arterioles, and venuoles. Hemoglobin exposed to light in the near-infrared range has specific absorption spectra that varies depending on its oxidation state; i.e., oxyhemoglobin ($HbO_2$) and deoxyhemoglobin (Hb) each act as a distinct chromophore. NIRS involves transmitting near-infrared light at specific different wavelengths, and measuring changes in transmitted or reflected light attenuation. NIRS enables concentration changes of the oxyhemoglobin ($HbO_2$) and deoxyhemoglobin (Hb) to be monitored. The ability to continually monitor cerebral oxygenation levels, for example, is particularly valuable for patients who are subject to a condition in which oxygenation levels may be compromised.

NIRS systems have been developed that include at least one NIRS sensor assembly, a base unit, and at least one interface cable for connecting the NIRS sensor assembly to the base unit. Each NIRS sensor assembly typically includes at least one light source and at least one light detector, and is operable to generate a detection light signal that is communicated to the base unit for processing. Detection light signals are sent from each NIRS sensor assembly to the base unit of the NIRS system via an interface cable.

A problem common to all NIRS systems is EMI from external sources. EMI can negatively affect the quality of the detection light signal. These problems are not limited NIRS systems; the same or similar problems exist in other signal monitoring systems. What is needed, therefore, is an improved signal monitoring system directed toward these and other problems.

## SUMMARY OF THE INVENTION

According to an aspect of the present invention, an apparatus for electrically and mechanically coupling a connection portion of a sensor assembly with a connection portion of an interface cable is provided. The apparatus includes a frame having an EMI shielding material. The frame defines a first port operable to engage the connection portion of the sensor assembly and a second port operable to engage the connection portion of the interface cable. The frame includes attachment features operable to mechanically secure the connection portion of the sensor assembly and the connection portion of the interface cable relative to the frame. The frame is configured to provide a Faraday Cage around substantially all of the connection portion of the sensor assembly and the connection portion of the interface cable when the connection portions are in coupled configuration.

According to another aspect of the present invention, an apparatus for sensing a biological characteristic of a subject is provided. The apparatus includes a sensor assembly, a base unit, and a coupler. The sensor assembly is operable to be attached to the subject, and is operable to produce electrical signals indicative of the biological characteristic being sensed. The sensor assembly includes a connection portion. The base unit includes a processor, and is operable to receive the electrical signals from the sensor assembly through an interface cable. The interface cable includes a connection portion. The coupler includes a frame having an EMI shielding material. The frame defines a first port operable to engage the connection portion of the sensor assembly and a second port operable to engage the connection portion of the interface cable. The frame includes attachment features operable to mechanically secure the connection portion of the sensor assembly and the connection portion of the interface cable relative to the frame. The frame is configured to provide a Faraday Cage around substantially all of the connection portion of the sensor assembly and the connection portion of the interface cable when the connection portions are in coupled configuration.

These and other objects, features, and advantages of the present invention apparatus and systems will become apparent in light of the detailed description of the invention provided below and the accompanying drawings. The apparatus and system described below constitutes a preferred embodiment of the underlying invention and does not, therefore, constitute all aspects of the invention that will or may become apparent by one of skill in the art after consideration of the invention disclosed overall herein.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagrammatic representation of an embodiment of the present signal monitoring system, with a NIRS sensor assembly applied to a subject.

FIG. **2** is a diagrammatic plan view of a NIRS sensor assembly.

FIG. **3** is a diagrammatic illustration of the coupler, with the NIRS sensor assembly connection portion and the interface cable connection portion depicted in an uncoupled configuration.

FIG. **4** is a diagrammatic illustration of the coupler, with the NIRS sensor assembly connection portion and the interface cable connection portion depicted in a coupled configuration.

FIG. **5** is a diagrammatic exploded view of the coupler, the NIRS sensor assembly connection portion, and the interface cable connection portion.

FIG. **6** is a diagrammatic exploded view of the coupler.

FIG. **7** is a diagrammatic view of the coupler joined with the interface cable connection portion as a unitary structure.

## DETAILED DESCRIPTION OF THE INVENTION

FIG. **1** illustrates a signal monitoring system **10** that includes a base unit **12**, a NIRS sensor assembly **14**, an interface cable **16**, and a coupler **18**. In alternative embodiments, the signal monitoring system **10** may include a plurality of NIRS sensor assemblies **14**, a plurality of interface cables **16**, and/or a plurality of couplers **18**. In some embodiments, the signal monitoring system **10** may also include one or more different types of sensor assemblies for signal monitoring; e.g., a sensor assembly that is of a type that is not a NIRS sensor type assembly. For ease of description, however, aspects of the present invention will be described in terms of the signal monitoring system **10** illustrated in FIG. **1**, which has a single NIRS sensor assembly **14**, a single interface cable **16**, and a single coupler **18**.

The base unit **12** includes a display **20**, operator controls **22**, and a processor for providing signals to and/or receiving signals from the NIRS sensor assembly **14**. The processor is adapted (e.g., programmed) to selectively perform the functions necessary to operate the NIRS sensor assembly **14**, including processing signals to and from the sensor assembly **14**, to create useful data. The functionality of the processor may be implemented using hardware, software, firmware, or a combination thereof. A person skilled in the art would be able to program the processor to perform the functionality described herein without undue experimentation. In embodiments in which the signal monitoring system **10** includes more than one NIRS sensor assembly **14**, the base unit **12** is adapted to selectively perform the functions necessary to operate the NIRS sensor assemblies **14**, including processing signals to and from the NIRS sensor assemblies **14**, to create useful data.

The NIRS sensor assembly **14** includes a sensor portion **24** and a connection portion **26**. In some embodiments, the NIRS sensor assembly **14** may additionally include pads, housings, EMI shielding, or other features, including, for example, the features described in International Patent Application No. PCT/US12/24889, which is hereby incorporated by reference. Such additional features will not be described in detail herein.

The sensor portion **24** of the NIRS sensor assembly **14** includes at least one light source. The light source is selectively operable to guide or emit infrared light (e.g., light in wavelength range of about 700 nm to about 1,000 nm), but is not limited to infrared light. For example, in some embodiments the sensor may include a light source that is operable to produce light at wavelengths outside the infrared range (e.g., in the range between 400 nm and 700 nm, or both visible and infrared light combinations, etc). The NIRS sensor assembly **14** is not limited to use with any particular type of light source embodiment. International Patent Application No. PCT/US12/24889, incorporated by reference hereinabove, discloses that acceptable light sources include light emitting diodes (LEDs), light transmitted through a fiber optic light guide, etc. As will be discussed further below, the light source may be mounted on a flexible electrical circuit disposed within the body **25** of the sensor portion **24** of the NIRS sensor assembly **14**.

The sensor portion **24** of the NIRS sensor assembly **14** further includes at least one light detector (e.g., a photodiode) that is operable to sense light emitted by the light source after such light passes through a portion of a subject's body. The light detector is operable to generate what will hereinafter be referred to as the "detection light signal". The detection light signal is indicative of the light sensed by that light detector, and the detection light signal is communicated to the base unit **12** of the signal monitoring system **10** for processing. The NIRS sensor assembly **14** is not limited to use with any particular light detector embodiment.

The connection portion **26** of the NIRS sensor assembly **14** is configured for mechanical connection with the coupler **18**, and electrical and mechanical connection with a connection portion **28** of the interface cable **16**, as will be explained below. The term "cable" as used herein, and except as further described herein, is defined to mean a bound group of one or more insulated electrical conductors.

In an embodiment of a NIRS sensor assembly **14** shown in FIG. **2**, the NIRS sensor assembly **14** includes a sensor portion **24** having a light source **30** and two light detectors **32**, **33** mounted on a flexible electrical circuit disposed within the body **25** of the sensor portion **24**. A lead portion **34** of the flexible electrical circuit extends out from the body **25** of the sensor portion **24**, and extends to the connection portion **26** of the NIRS sensor assembly **14**. Alternatively, a cable may be attached to the flexible electrical circuit disposed within the body **25** of the sensor portion **24**, which cable extends to the connection portion **26**. The connection portion **26** may include a printed circuit board card **36** (i.e., a "PCB card"). The light source **30** and the light detectors **32**, **33** are mounted proximate one end of the flexible electrical circuit, and the PCB card **36** is mounted to the opposing end of the flexible electrical circuit. The NIRS sensor assembly **14** is not limited to the embodiment illustrated in FIG. **2**; e.g., in other embodiments, the sensor portion **24** of the NIRS sensor assembly **14** need not include a flexible electrical circuit, and the connection portion **26** need not include a PCB card **36**.

Referring again to FIG. **1**, the interface cable **16** includes a first end portion **40** and an opposing second end portion **42**. The first end portion **40** of the interface cable **16** includes the connection portion **28** that is configured to mechanically connect with the coupler **18**, and electrically and mechanically connect with the connection portion **26** of the NIRS sensor assembly **14**. The connection portion **28** of the interface cable **16** includes an electromechanical connector **66**, such as a DisplayPort type connector, for electromechanical connection with the connection portion **26** of the NIRS sensor assembly **14**. The connection portion **28** is not, however, limited to a DisplayPort type connector, and may alternatively use other types of electromechanical connectors; e.g., commercially available or custom electromechanical connectors. In some embodiments, the connection portion **28** may include mating attachment features configured to mate with the coupler **18**. The second end portion **42** of the interface cable **16** is connected to the base unit **12** of the signal monitoring system **10**.

Referring to FIGS. **1**, and **3-7**, the coupler **18** electrically and mechanically connects the NIRS sensor assembly **14** with the interface cable **16**. The coupler **18** includes an internal frame **19**, and preferably includes a housing **82**. The coupler **18** may be described as having a length extending along the x-axis, a width extending along the y-axis, and a height extending along the z-axis (e.g., see FIG. **5**). The frame **19** includes one or more walls that define a first port **44** and a second port **46**. The first port **44** is configured to receive the connection portion **26** of the NIRS sensor assembly **14**. The second port **46** is configured to receive the connection portion **40** of the interface cable **16**. The frame walls are formed from, or include, at least one EMI shielding material, and the walls collectively form a Faraday Cage. For example, the frame **19** may be made from a stainless steel material, or an electrically conductive wire mesh (e.g., copper wire mesh), or combinations thereof. The frame **19** material is not, however, limited to these materials. In some embodiments, an EMI shielding material can also be partially or completely wrapped around the frame **19** to provide additional EMI shielding. An example of an acceptable electrically conductive tape is XYZ-Axis Electrically Conductive Tape 9713, offered by 3M Company of St. Paul, Minn., USA. The EMI shielding material is not, however, limited to this example. An electrically conductive, fiber-filled adhesive tape (e.g., the 9713 Tape) provides several advantages, including: (1) it is relatively inexpensive; (2) it does not require a soldered connection to ground; (3) it is available in roll form; (4) it has a low profile; and (5) it is flexible. The frame **19** is configured so that, in a "coupled configuration", shown for example in FIG. **1** and discussed further below, the connection portion **26** of the NIRS sensor assembly **14** and the connection portion **28** of the interface cable **16** are at least partially disposed within a Faraday Cage.

FIGS. **3** and **4** illustrate the difference between an "uncoupled configuration" and a "coupled configuration". FIG. **3** illustrates the NIRS sensor assembly **14**, the interface cable **16**, and the coupler **18** in an "uncoupled configuration". In FIG. **3**, the connection portion **26** of the NIRS sensor assembly **14** is not inserted into the first port **44** of the coupler **18**, and the connection portion **28** of the first end portion **40** of the interface cable **16** is not inserted into the second port **46** of the coupler **18**. FIG. **4** illustrates the NIRS sensor assembly **14**, the interface cable **16**, and the coupler **18** in a "coupled configuration", wherein the connection portions **26**, **28** are electrically and mechanically connected; i.e., the connection portion **26** of the NIRS sensor assembly **14** is inserted into the first port **44** of the coupler **18**, and the connection portion **46** of the first end portion **40** of the interface cable **16** is inserted into the second port **46** of the coupler **18**. In FIGS. **3** and **4**, the connection portions **26**, **28** are diagrammatically shown as mating male and female connectors. The connection portions **26**, **28** are not limited to mating male and female connectors, however. In addition, the connection portions **26**, **28** need not be directly connected to one another as shown in FIGS. **3** and **4**; e.g., in some embodiments, the coupler **18** may include structure that electrically and mechanically connects the two connection portions **26**, **28**.

FIG. **5** illustrates an exploded view of an embodiment of the coupler **18** with the housing **82** omitted to facilitate the description, together with the connection portion **26** of the NIRS sensor assembly **14** and the connection portion **28** of the interface cable **16**. In FIG. **5**, the NIRS sensor assembly **14**, the interface cable **16**, and the coupler **18** are in an "uncoupled configuration". In the embodiment illustrated in FIG. **5**, the connection portion **26** includes a PCB card **36**, a top body portion **52**, and a bottom body portion **54**. The PCB card **36** includes a plurality of leads **56**, each operable to mechanically and electrically connect with a corresponding port **58** on the connection portion **28** of the interface cable **16**, as will be discussed further detail below. The top and bottom body portions **52**, **54** are attached to the PCB card **36**, for example, using one or more mechanical fasteners, ultrasonic welding, adhesives, or other means for attaching, including a molding process. In the embodiment illustrated in FIG. **5**, the connection portion **26** is operable to be received by the first port **44** of the coupler **18**. In the embodiment illustrated in FIG. **5**, the top body portion **52** includes an alignment feature **60** operable to engage with a corresponding alignment feature of the coupler **18** (not visible in FIG. **5**). The alignment feature **60** is operable to aid in alignment as the connection portion **26** is received by the first port **44** of the coupler **18**. The top and bottom body portions **52**, **54** may be made of plastic or other non-electrically-conductive material.

In the embodiment shown in FIG. **5**, the top body portion **52** includes mating attachment features **62** (e.g., clips, etc.) operable to engage corresponding mating attachment features **64** in the frame **19**. In some embodiments, both the top and bottom body portions **52**, **54** may include mating attachment features operable to engage corresponding mating attachment features in the frame **19**. The engagement of mating attachment features **62** of one or both of the body portions **52**, **54** with the corresponding mating attachment features **64** of the frame **19** may form a snap fit, a compression fit, or the like. The engagement of mating attachment features of the body portions **52**, **54** and the frame **19** can be configured to create a sound (e.g., a snapping or clicking) that is an audible indication to the user that the connection has been made. The engagement of mating attachment features **62** of the body portions **52**, **54** with the corresponding mating attachment features **64** of the frame **19** can also be configured to bias the body portions **52**, **54** and the coupler **18** together with a predetermined retention force. The magnitude of the retention force may be selected to suit the application at hand; e.g., the mating attachment features may be configured to create a retention force equal to, greater than, or less than the force with which sensor portion **24** of the NIRS sensor assembly **14** is attached to the subject being monitored. For example, in some embodiments, the sensor portion **24** of the NIRS sensor assembly **14** includes an adhesive that requires a force of "N" pounds applied (e.g., laterally applied) to remove the sensor portion **24** from the subject being monitored. The aforesaid retention force that biases the body portions **52**, **54** together with the coupler **18** may be selected so that the retention force is equal to, greater than, or less than force necessary to remove the sensor portion **24** of the NIRS sensor assembly **14** from the subject being monitored.

In the embodiment shown in FIG. **5**, the connector **66** within the connection portion **28** of the interface cable **16** is a DisplayPort type connector. The connector **66** includes attachment features (not shown in FIG. **5**) that engage corresponding attachment features **68** of the coupler **18**. In some embodiments, the attachment features may be "mating" features; e.g, male and female, etc. The connector **66** includes a plurality of ports **58**, each operable to mechanically and electrically connect with a corresponding lead **56** on the PCB card **36** of the connection portion **26** of the NIRS sensor assembly **14**.

In the embodiment illustrated in FIG. **5**, the internal frame **19** has a rectangular configuration that includes a top wall **70**, a bottom wall **72**, a first side wall **74**, a second side wall **73**. The first side wall **74** and the second side wall **73** extend in a height wise direction between the top wall **70** and the bottom wall **72**. The four walls of the frame **19** define an internal cavity. The term "cavity" is used herein to mean a void or an open space. The four walls of the frame **19** also define at least a portion of the first port **44** and the opposing second port **46**. As indicated above, the four walls of the frame **19** collectively form a Faraday Cage. The cavity defined by the four walls of the frame **19** may be described as being the inside the Faraday Cage. The present coupler **18** is not limited to the rectangular configuration shown in FIG. **5** (e.g., having a plurality of walls **70**, **72**, **73**, **74**) and may, for example include a cylindrical configuration having a single wall.

Referring still to FIG. **5**, the top wall **70** of the frame **19** includes mating features **64** proximate the first port **44**. The mating attachment features **64** are configured to mate with the corresponding mating attachment features **62** on the top body portion **52**. For example, the specific embodiment shown in FIG. **5** illustrates mating attachment features **64** in the form of clips that are configured to engage mating attachment features **62** in the form of apertures or depressions in the top body portion **52**. The top wall **70** of the frame **19** also includes mating attachment features **68** proximate the second port **46** which are configured to mate with corresponding mating attachment features included in the connection portion **28** of the interface cable **16** (not visible in FIG. **5**); e.g., the same as or similar to those shown for mating attachment features **62**, **64**. The frame **19** can include an alignment feature (not visible in FIG. **5**) operable to engage the corresponding alignment feature **60** of the top body portion **52** of the connection portion **26** of the NIRS sensor assembly **14**. The corresponding alignment features aid in correct alignment between the connection portion **26** of the NIRS sensor assembly **14** and the coupler **18** during connection. In the embodiment illustrated in FIG. **5**, the frame **19** includes a slotted tab **76** extending from the second side wall. The slotted tab **76** is configured for connection with a ground terminal; e.g., via a ring terminal.

Pieces of tape **78**, **80** (e.g., 9713 Tape) may be attached to the top wall **70** and bottom wall **72** of the frame **19**, respectively, to cover openings in the top and bottom walls **70**, **72** of the frame **19**, or to cover the entire frame **19** as described above.

In operation of the coupler **18** embodiment illustrated in FIG. **5**, the connection portion **26** of the NIRS sensor assembly **14** can be moved in a lengthwise direction until it is inserted into the first port **44** of coupler **18**. The mating attachment features **62** of the top body portion **52** slidably engage the corresponding mating attachment features **64** of the frame **19** to retain the two elements together. In similar fashion, the connection portion **28** of the interface cable **16** can be moved in a lengthwise direction until it is inserted into the second port **46** of the coupler **18**. The mating features of the connection portion **28** of the interface cable **16** (not shown in FIG. **5**) slidably engage the corresponding mating attachment features **68** of the frame **19** to retain the two elements together. In this coupled configuration, each of the leads **56** on the PCB card **36** of the connection portion **26** mechanically and electrically connect with corresponding ports **58** in the connector **66** of connection portion **28**, and at least a portion of the connection portions **26**, **28** are disposed within the cavity. As discussed above, the cavity is inside the Faraday Cage defined by the four walls of the internal frame **19**. Thus, in this coupled configuration, at least a portion of the connection portions **26**, **28** are disposed within the Faraday Cage. As a result, the point of contact between the NIRS sensor assembly **14** and the interface cable **16** is shielded against EMI.

The exploded view of FIG. **6** illustrates the internal frame **19** described above with regard to FIG. **5** (i.e., the top wall **70**, the bottom wall **72**, the first side wall **74**, and the second side wall), and the housing **82** of the coupler **18**. The housing **82** is configured to enclose the four walls of the frame **19**. The housing **82** is preferably made of plastic or some other non-electrically-conductive material. The housing **82** may be constructed using one or more pieces. The housing **82** may be configured so that when the connection portion **26** of the NIRS sensor assembly **14** is received within the first port **44** of the coupler **18**, a seal is formed between the housing **82** and the connection portion **26** of the NIRS sensor assembly **14**, thereby preventing liquid and/or gas from entering the first port **44** of the coupler **18**. In the embodiment illustrated in FIG. **6**, the housing **82** includes an orientation feature **83** operable to indicate the orientation of the coupler **18** to the user; e.g., the orientation feature **83** may indicate the correct orientation of the housing **82** relative to the connection portion **26** of the NIRS sensor assembly **14**. The coupler **18** is not limited to the housing **82** embodiment illustrated in FIG. **6**.

FIG. **7** illustrates an embodiment of the coupler **18**, wherein the housing **82** encloses the four walls of the internal frame **19** (i.e., the top wall **70**, the bottom wall **72**, the first side wall **74**, and the second side wall) and the connection portion **28** of the interface cable **16** is permanently received within the second port **46** of the coupler **18**. In this embodiment, the first end portion **40** of the interface cable **16** is disposed within an extension **84** of the housing **82**.

Referring again to FIG. **1**, in the operation of the signal monitoring system **10**, once the NIRS sensor assembly **14** is positioned relative to the subject's skin, the NIRS sensor assembly **14** is used to introduce light signals into the subject's body tissue. The light introduced into the subject's body tissue is subsequently detected and a detection light signal is generated. The detection light signal is relayed back to the base unit **10** via the interface cable **16**, where the detection light signal is processed and analyzed to obtain data; e.g., relating to the oxygenation level of the subject's body tissue. The coupler **18** prevents EMI from being introduced to the detection light signal at the point of contact between the NIRS sensor assembly **14** and the interface cable **16**.



While various embodiments of the present invention have been disclosed, it will be apparent to those of ordinary skill in the art that many more embodiments and implementations are possible within the scope of the invention. For example, embodiments of the connection portion of the sensor assembly are described above including a printed circuit board, and embodiments of the interface cable are described above as including a DisplayPort connector. In alternative embodiments, the PCB and the DisplayPort connector can be attached to the other of the interface cable and the sensor assembly respectively; i.e., switched vice versa. Accordingly, the present invention is not to be restricted except in light of the attached claims and their equivalents.

What is claimed is:

**1**. An apparatus for electrically and mechanically coupling a connection portion of a sensor assembly with a connection portion of an interface cable, comprising:

a frame having an EMI shielding material, which frame defines a first port operable to engage the connection portion of the sensor assembly and a second port operable to engage the connection portion of the interface cable;

wherein the frame includes attachment features operable to mechanically secure the connection portion of the sensor assembly and the connection portion of the interface cable relative to the frame; and

wherein the frame is configured to provide a Faraday Cage around substantially all of the connection portion of the sensor assembly and the connection portion of the interface cable when the connection portions are in coupled configuration; and

wherein the connection portion of one of the interface cable and the sensor assembly includes a printed circuit board, and the other of the interface cable and the sensor assembly includes a DisplayPort connector.

**2**. The apparatus of claim **1**, wherein the apparatus further comprises a housing configured to enclose the frame, which housing is formed of an electrically non-conductive material.

**3**. The apparatus of claim **1**, wherein the frame is configured to form an internal cavity surrounded by one or more walls, and a first end of the cavity defines the first port and is configured to receive the connection portion of the sensor assembly, and an opposing second end of the cavity defines the second port and is configured to receive the connection portion of the interface cable.

**4**. The apparatus of claim **3**, wherein the cavity is configured such that the frame walls surround substantially all of the connection portion of the sensor assembly and the connection portion of the interface cable when the connection portions are in coupled configuration.

**5**. The apparatus of claim **4**, wherein the walls include the attachment features operable to mechanically secure the connection portion of the sensor assembly and the connection portion of the interface cable relative to the frame.

**6**. The apparatus of claim **5**, wherein the attachment features are positioned to maintain a mechanical and electrical connection between the connection portions.

**7**. The apparatus of claim **6**, wherein the attachment features are positioned to bias the connection portions together.

**8**. The apparatus of claim **6**, wherein the attachment features are configured such that a predetermined amount of force is required to separate one or both of the connection portions from the frame.

**9**. The apparatus of claim **8**, wherein the predetermined amount of force is equal to or less than an amount of force required to remove the sensor assembly adhered to a subject.

**10**. The apparatus of claim **6**, wherein the cavity is configured such that the frame walls surround substantially all of the printed circuit board and the DisplayPort connector when they are in coupled configuration.

**11**. An apparatus for sensing a biological characteristic of a subject, comprising:

a sensor assembly operable to be attached to the subject, which sensor assembly is operable to produce electrical signals indicative of the biological characteristic being sensed, and which sensor assembly includes a connection portion;

a base unit having a processor, which base unit is operable to receive the electrical signals from the sensor assembly through an interface cable, and which interface cable includes a connection portion; and

a coupler that includes a frame having an EMI shielding material, which frame defines a first port operable to engage the connection portion of the sensor assembly and a second port operable to engage the connection portion of the interface cable, wherein the frame includes attachment features operable to mechanically secure the connection portion of the sensor assembly and the connection portion of the interface cable relative to the frame, and wherein the frame is configured to provide a Faraday Cage around substantially all of the connection portion of the sensor assembly and the connection portion of the interface cable when the connection portions are in coupled configuration.

**12**. The apparatus of claim **11**, wherein the coupler further comprises a housing configured to enclose the frame, which housing is formed of an electrically non-conductive material.

**13**. The apparatus of claim **11**, wherein the frame is configured to form an internal cavity surrounded by one or more walls, and a first end of the cavity defines the first port and is configured to receive the connection portion of the sensor assembly, and an opposing second end of the cavity defines the second port and is configured to receive the connection portion of the interface cable.

**14**. The apparatus of claim **13**, wherein the cavity is configured such that the frame walls surround substantially all of the connection portion of the sensor assembly and the connection portion of the interface cable when the connection portions are in coupled configuration.

**15**. The apparatus of claim **14**, wherein the walls include the attachment features operable to mechanically secure the connection portion of the sensor assembly and the connection portion of the interface cable relative to the frame.

**16**. The apparatus of claim **15**, wherein the attachment features are positioned to maintain a mechanical and electrical connection between the connection portions.

**17**. The apparatus of claim **16**, wherein attachment features are positioned to bias the connection portions together.

**18**. The apparatus of claim **16**, wherein the attachment features are configured such that a predetermined amount of force is required to separate one or both of the connection portions from the frame.

**19**. The apparatus of claim **18**, wherein the predetermined amount of force is equal to or less than an amount of force required to remove the sensor assembly adhered to a subject.

**20**. The apparatus of claim **16**, wherein the connection portion of one of the interface cable and the sensor assembly includes a printed circuit board, and the other of the interface cable and the sensor assembly includes a DisplayPort connector, and the cavity is configured such that the frame walls surround substantially all of the printed circuit board and the DisplayPort connector when they are in coupled configuration.

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